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OVIPOSITOR OF CRYPTUS SAMIÆ.

JOURNAL
OF THE
NEW-YORK MICROSCOPICAL SOCIETY.

VOL. VI. OCTOBER, 1890. No. 4.

THE OVIPOSITOR OF CRYPTUS SAMIÆ PACK.

BY LUDWIG RIEDERER.

(*Read February 7th*, 1890.)

The members of this genus of hymenopterous parasites are conspicuous on account of the length of the exserted ovipositor. This latter is composed of the ovipositor proper, and the two enclosing sheaths. These originate from the end of the abdomen, while the ovipositor proper protrudes from the ventral line of the abdomen, behind the sixth ring. The oviduct reaches this place in a forward direction, and there connects with the ovipositor, where it makes a bend downward and backward. As a consequence the thence straightening tube reaches far behind the body of the insect. Several bundles of muscles run from the point of exit of the ovipositor, in both an upward and backward direction, the latter bundles extending towards the anal end of the abdomen. The ovipositor proper is formed by one dorsal and two ventral parts, and they are fastened together in such manner that they can slide up and down upon each other, as far as the corresponding muscles in the abdomen will allow, but the parts cannot be separated sidewise.

Description of Plate 25.

I., II.—Dorsal parts, × 350.

III., IV.—Ventral parts, × 350. The combination of the tubes gives the greatest strength for the least material employed. The substance of the tubes is thickest on the sides of the surface, and near the tongues and grooves, and it is thinnest and most flexible on the sides which form the vertical slit. The soft substance and tracheæ are seen in the tube.

V., VI.—Appendices to ventral parts, connected by elastic joints, × 800. Figs. I.–VI. are drawn with the camera.

VII., VIII.—Diagrams to show the ovipositor while closed, and also while extended by the passing of the egg. Jo, Joint of dorsal part. Sl, Slit, forming passage for the egg. Tr, Tracheæ enclosed with soft substance in the tubes. To, Tongues. gr, Grooves. Ap, Appendices on the ventral parts. E, Egg.

When searching for information about the shape of the constituent parts, I could find only a few descriptions and sketches, and all of them were so indefinite that it was evident they were made more by employment of imagination than of actual observation. It is therefore interesting to study the shape of these parts, and their working together for their intended purpose. By means of the microscope we can see that the parts are barbed in different ways, as I showed at the meeting of January 4th, 1889. But, besides several lighter and darker shaded lines, we cannot find out much that is instructive about the form of the interior. The preparation of cross-sections does not furnish very promising results, because chitine—the main substance of the ovipositor—is so hard and brittle that out of a considerable number of sections sometimes none will show enough for an explanation. As the imago of the insect gave so little hope for success, I tried different states of development of the pupa, up to the time when the imago is just emerging, and this last state gave the best results.

The chitine skeleton of insects develops to the proper shape while the insect lies dormant as a pupa, and is still soft when the imago emerges, but hardens in a few hours, when out of the pupal skin. I had on hand a few cocoons of the large moth, *Platysamia cecropia*, infested with a brood of *Cryptus samiæ Pack.*, belonging to the family Ichneumonidæ, and thus I succeeded in procuring the different states of development. This insect gives the following approximate measurements: length of head, thorax and abdomen, 10 mm.; expanse of wings, 16 mm.; length of antennæ, 5 mm.; length of ovipositor, 6 mm.; diameter of the same, 0.2 × 0.1 mm.

The ovipositor, on the cross-section, shows that it is composed of four tubes, which are so compressed as to give an oval shape. The four tubes are all separated from each other, excepting the two dorsal ones. These are fastened together along the dorsal line into one single piece. At the line of contact between the dorsal and the ventral parts, the dorsal part has two projections or tongues, each one having the shape of the capital letter, "T." These T-shaped tongues are fitted into grooves of the same shape in the ventral parts. By this arrangement the dorsal and the two ventral parts can slide alongside of each other, as far as the muscles inside the abdomen will allow; but, by the same

arrangement, they are prevented from separating laterally. As the two dorsal parts are fastened together in one piece only along a fine line on the surface, this allows the two parts to be separated from each other for a certain distance, like the two sides of a hinge. Yet as soon as any force ceases to separate them, the elasticity of the joint will bring together again the two sides of the ovipositor. The passage of the egg from the oviduct into the slit, formed by the two sides of the ovipositor, tends to separate these parts, and at the same time, by the elasticity of these latter, the egg is firmly held in the slit. By the reciprocal movement of the sliding parts the egg is forced forwards. Yet the pressure exercised on the egg by this means is alleviated by the flexibility and thinness of the sides of the ventral parts forming the slit. Besides this the tube of the ventral parts is filled by a soft plastic substance, in which is embedded a trachea of good size, all acting like an air-cushion. Two small projections at the edges of the ventral parts prevent the egg from escaping sidewise. When not in use, these "appendices" are kept between the two ventral parts, close to their inner sides, by the elasticity of the connecting joints.

The pupa shows five wide tubes, bent around the end of the abdomen, and reaching well forward on the dorsal part of the insect. In these five tubes are contained, separate from each other, the one dorsal part, the two ventral parts, and the two sheaths. The less the development of the pupa has progressed, the less is visible of the finer structure of the single parts. The parts representing the tubes of the future ovipositor proper are homogeneous, showing no, or, later on, but slight differentiation. In the dorsal part no slit is visible, and but a trace of the projecting tongues, and the grooves in the ventral parts do not yet appear. Thus the union of the one dorsal and the two ventral parts of the pupa, into the ovipositor of the imago, takes place at the time when the mature insect bursts open the pupal skin, and forces its way out. Then the soft tongues enter the grooves, and the parts assume their proper shape and hardness. In this manner, it seems to me, takes place the formation of the ovipositor, a complex organ, composed of the formerly separated single parts.

THE TERMITES OF THE ISTHMUS OF PANAMA.

BY P H. DUDLEY, C. E.

(*Read April 4th*, 1890.)

In the previous paper on "Termites from the Isthmus of Panama," it will be remembered I stated three genera had been identified by Dr. Hagen, viz.: *Termes*, *Eutermes* and *Calotermes;* the first being represented by five (5) species, the second by three (3) species and the third by only one species. With one exception, the injury and destructive work to buildings, wood-work, cars, locomotive cabs, and furniture, had been done by species of the *Termes* and *Eutermes.* The exception was the injured portions of a first-class coach in daily service, attacked by *Calotermes marginipennis Latrielle*, as identified by Dr. Hagen. This species is found in Mexico, Central America, and California, though possibly not a native of that State. It is now known that they are frequently transported from one country to another, in trunk frames and wooden utensils.

During the past year a number of species of *Calotermes* have been found upon the Isthmus, and much more is now known of their habits in that locality. With the exceptions of their great destructiveness to sound wood-work, and rapid increase in numbers, they materially differ from either of the other two genera.

The *Calotermes* on the Isthmus do not have a distinct class of members, known as workers, and, in the large communities, only a small percentage of soldiers have been found.

No evidence of the *Calotermes* constructing large nests or galleries on the exterior surfaces of wood-work, trees, or even buildings, has so far been found upon the Isthmus. After entering a piece of wood-work or furniture, through a small crevice of a joint, or by boring an orifice from an adjacent piece of wood, they eat out the interior, in small pockets, entering each by a small orifice on the side, only sufficient to admit one insect at a time. Mr. Beaumont thinks, there being no extensive galleries, the small amount of guard-duty required, explains in a measure why there are so few soldiers. They are the only blind members in the community, and, being wingless, they do not swarm.

Only small queens of the genus *Calotermes* have been obtained upon the Isthmus, but there are great numbers of them

in the large communities, and the increase in numbers is very rapid. In the seat-rails in the coaches, which were destroyed by *Calotermes marginipennis Latrielle*, Mr. Beaumont estimated that nearly one-half of the number of the insects was females.

The *Calotermes* are dangerous pests, from their secluded habits. And, with one exception, they scarcely give any indication that they are in wood-work of buildings, coaches or furniture. The exception is the presence of little pellets of partially digested wood, about $\frac{1}{50}$ of an inch long, and $\frac{1}{100}$ of an inch in diameter. These are found upon the floor. In eating out the pockets in the wood they are careful to leave a thin partition between adjoining pockets. This is undoubtedly due to the instinct of danger from breaking through a surface I have one pocket which probably was one of the first constructed in the wood, and subsequently the wood surrounding it was eaten, leaving it intact, its support being derived from the tube, which was formed by leaving the wood containing the orifice or entrance to the pocket. No evidence has been found of the *Calotermes* repacking the excavated wood with solid material, making it into nests, as is the case with the *Termes*.

Sometimes a pocket will be found partially filled with the loose pellets before mentioned, but the majority are empty.

Because the *Calotermes* have no workers, in the sense of the other genera, I do not wish to convey the impression that they are idlers. On the other hand, they are very aggressive and voracious, eating hard, sound woods, which the other genera are not as liable to do. From the fact that the hard, sound wood wears away their mandibles, I am induced to think that naturally they live on soft wood or that undergoing decay.

In a recent communication I partly explained the reason of their ability to eat hard woods, notwithstanding the fact that the wood wears off the cutting portions of their mandibles, *i. e.*, the anterior teeth by which they sever the wood from the block. So far as now observed by Mr. Beaumont, and judging by the specimens of insects of the *Calotermes* sent to me, a large percentage of a community is composed of larvæ and nymphæ. A nympha will undergo several moultings before reaching the imago state, and at each moult will be provided with a new set of mandibles, replacing the older worn ones, and the wood cutting goes on with little interruption. When the mandibles of the imago

are worn, it is fed. Slide No. 32 shows the position of the mandibles for cutting wood. Mastication of the chip is performed by the posterior dentition. Slide No. 4 shows the worn mandibles.

Mr. Beaumont had several young *Calotermes* queens in white ash blocks for observation under his microscope, and saw them frequently cut a chip from the block. When the queen's mandibles became so worn that she could not do so, then she would starve. If, however, nymphæ were put in the block, which could cut the wood and feed the queen, then she would thrive. Mr. Beaumont's ash blocks are 3¼ inches long by 1¼ inches square, on the upper side of which he grooves to receive a glass slide. Under the slide he cuts small V-shaped grooves into which he places a few living members of different species, and then covers them with the glass slide. In this way he could put the blocks under the microscope and observe the insects, and he learned more of their habits than could have been done in any other way. In many of these blocks he had pairs of several different species of Termites with two or three eggs, and as many larvæ.

Before mentioning some of these observations, I will describe how he obtained the little colonies he placed in his blocks, as it illustrates an interesting phase in the life-history of the Termites, and is common to the three genera upon the Isthmus. On the beach at Colon, in Coral avenue, near his house, and the shops of the Panama Railroad, stands a large Coccoloba, or sea-grape tree. It is really a tree of refuge for insects. I have two photographs of the tree taken from opposite sides. It will be noticed the tree is inclined, due to the constant direction of the trade-winds during the dry season, corresponding to our winter and spring. The bark of the Coccoloba is rough, thick and comparatively soft. The older layers are easily penetrated by insects. Mr. Beaumont says larvæ of a species of saw-fly bore into the bark, forming a small pocket, which is soon vacated. The entire life-history of this fly is shown in a series of vials with exhibit No. 26.

In the vacant pockets a pair of Termites finds a hiding place. Species of all genera upon the Isthmus have been found in the bark, all within the space of a few inches square. Each is, however, entirely distinct, without any connection one with the other.

Finding these little pockets occupied with pairs of Termites, Mr. Beaumont cut out portions of the bark, containing pockets and little colonies, and transferred them to recesses prepared in his ash blocks. The first pair transferred had two larvæ and seven eggs. Some of these eggs hatched, one producing the larva of a *nasuti* soldier, and others the larvæ of workers. These continued to thrive for four or five months, but they did not like the light, or their doings investigated, and tunneled under the bark, keeping out of sight. As long as they could be observed, the queen cared for the larvæ at first, but as soon as the larvæ workers were a few days old they also assisted. One or two moultings occurred, which occupied about one hour of time. This was much shorter than the observed time for transformations of the *Calotermes*. The queens found in these pockets are very small, but little larger than when they swarm and lose their wings. Making sections of the queens in this stage eight to ten nearly mature eggs are found. But little development, however, has taken place in the ovarian tubes beyond the nearly mature eggs.

This feature has been noticed by others, when making dissections of the young queens after swarming. The true explanation of this is yet to be ascertained. Several pairs of *Calotermes* were transferred from the Coccoloba tree to the ash blocks. They did not object to the light, and their movements and actions were readily studied.

One pocket contained a pair and three eggs. Mr. Beaumont had the pleasure of seeing a larva emerge from the egg, and in an hour or two saw it take its first supply of food, while observing it under the microscope.

The larva, crawling to the posterior of the queen's abdomen, touched it with its antennæ, opened its mouth and received a supply of some fluid food. This statement only applies to the *Calotermes;* feeding of the larvæ of the other genera, has not been reported by Mr. Beaumont.

The little pellets of partially digested wood are also used as food by the *Calotermes*, being fed to the imago with worn mandibles, and to the youngest nymphæ as now observed. Mr. Beaumont finds when a queen and larva are placed in one of his ash blocks, the larva flourishes as long as the queen can cut the food from the block. But when her mandibles become so worn that she can not do so the larva dies, and eventually the queen.

Mr. Beaumont found in the Coccoloba tree a small colony of *Calotermes*, the soldier of which is like the one figured by Dr. Hagen as *Calotermes flavicollis*. The largest of these soldiers was ¾ of an inch long, and was armed with powerful mandibles. Several more soldiers from the same nest were over ½ of an inch long, and had the appearance of not being fully grown. These are by far the largest soldiers from the Isthmus so far discovered, and are shown as specimens No. 5.

No large colonies of the same species have been found upon the Isthmus, though they may exist. *C. flavicollis* is not known to have been found in Central, South, or North America, but is in Spain, Italy and Egypt. A large amount of the plant used in the excavation of the Suez Canal went to the Isthmus, and it is possible, *Calotermes flavicollis* was in the timber portions of the plant.

It will be remembered that I stated that in the communities of the *Termes* and *Eutermes*, beside a queen, or queens and kings, their were soldiers and workers, the latter being many times the most numerous. Of young there would be larvæ and nymphæ of several ages, many of the latter with long wing-cases developing into winged imagines, both male and female, previous to the swarming season. The winged imagines all have eyes, and swarm, while the soldiers and workers are blind, and do not swarm. The soldiers do guard-duty and defend the community against minor attacks, though, when the community is attacked in great numbers, the workers assist in the defence. Mr. Beaumont watching *Termes testaceus* swarm, from a nest in a yellow pine sill, said the soldiers surrounded the orifice from which the insects issued, and stood guard with their mandibles open.* Upon the workers devolves all the labor of nest building, construction of the extensive systems of galleries, tunnelling the wood, rearing the young, and caring for the queens.

Mr. Beaumont, who has watched several species of the *Termes* and *Eutermes* in his glass termitaria, says the work is done in a very orderly, and systematic manner.

The soldiers of the *Termes* have long sickle-shaped mandibles, operated by powerful muscles.

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* Observations of May, 1889.

The heads of the soldiers of the *Eutermes* terminate in a long beak, containing a tube or gun, from which a glutinous shot can be thrown. This is a singular provision of nature. The smallest member of the community being provided with such an effective weapon, that at some distance one can put an antagonist even twice his size *hors de combat*, the legs and antennæ of the latter rendered useless by the quick drying viscid shot. Cuts of the heads of the *nasuti* soldiers will be found in my previous paper.

As complex as the members and habits of a *Termes* community may seem from the above; I have now a series of specimens of *Termes minimus* Beaumont, showing them to be far more complex.

These specimens have just been received from Mr. Beaumont, and are the most complete of any series known of a single species. In the genus *Termes*, besides the true queens and kings, there are supplementary queens and kings, and several stages of larvæ and nymphæ incident to the latter forms.

The fact of there being two classes of queens was stated as early as 1856 by Mr. Charles Lespes, in his investigations of *Termes lucifugus* at Bordeaux, France.

Dr. Fritz Müller made a series of observations in Brazil, confirming the general fact, and sent some of his results to Mr. Charles Darwin.

In 1872 Müller published his observations, which were of a longer duration than Lespes, and included species of the three genera we have mentioned. When he speaks of *Eutermes*, I am unable to determine whether he means species with mandibles, or those with beaks. In some details Müller does not agree with Lespes, but confirms the general facts.

Lespes found in the species of *Termes lucifugus* nymphæ of two forms, viz.:

1st. Those with long wing cases.

2nd. Those with short wing cases.

He designated the 1st as nymphæ of the first form, and the 2nd as nymphæ of the second form.

He stated, from the 1st form came the large queens and kings, and from the 2nd form small queens and kings, which are now designated as supplementary. Lespes stated that the winged imagines from the nymphæ would swarm the last of May or the fore part of June.

The nymphæ of the 2nd form would remain in the nest. At the time of the swarming of the imagines from the 1st form, Lespes states that he never saw a winged imago from the nymphæ of the 2nd form, but expects there would be, swarming taking place in August or September. The last was merely conjecture, and Müller says, according to his observations, was wrong. He found the wing-cases of the nymphæ of the 2nd form to be only rudimentary, and the imagines from them being wingless remained in the old nest.

The specimens of the nymphæ of the 2nd form, the imago and gravid queens, sent up by Mr. Beaumont, only have rudimentary wing-cases, and could not swarm. Three stages of larvæ and nymphæ have so far been found by Mr. Beaumont of the 2nd form, and he expects to find others. Interesting as this matter is scientifically, it is equally so practically.

Ample provision seems to be made for the dissemination of the inmates of a colony to form new ones, and at the same time fully providing for the perpetuation of the old one, making it very difficult to destroy a well-established colony.

Mr. Beaumont finds many of the nests destroyed by taking out the queen-cell and the queen or queens, were rebuilt in a few months, containing other queens. It will be remembered that in my previous paper I stated, when the galleries leading to and from a nest were destroyed, they were soon rebuilt. The latter will be more readily understood after seeing a lantern view of a nest.

The habits of each of the three genera of Termites, found upon the Isthmus, are so different that remedies, which may be effectual against one genus, may not be so against another, and in order to carry out practical measures, checking their destructiveness, it has become necessary to designate each genus so that ordinary workmen can distinguish them.

In my paper of last year, I stated that *Eutermes*, was made a sub-genus of *Termes*, owing to a peculiar venation of the wing. This means of classification included species having soldiers with mandibles, and species having soldiers with beaks in the same genus. On the Isthmus the venation of the wings is not constant, nor can winged insects be found at all seasons of the year. And authorities do not agree in identification. In my first paper, for the time being, I called all those species with

beaks *Eutermes*. This by no means avoids the confusion in the matter. And further study indicates that the habits of the two genera are so different that I now propose to call all those species having soldiers with beaks *Milesnasitermes*, soldier-nosed-termes.

The workmen know when they break a gallery and find a mandibulate soldier that the nest is likely to be inside of some post or beam near by, unless it should be a species of *Termes columnar*, in which case it is likely to be a mud nest, rising from the ground. These Termites belong to the genus *Termes*. On the other hand, when they break a gallery and find a soldier with a beak, the nest may be a long distance from that point, but it will be on the exterior of the wood, or tree. These Termites belong to the genus *Milesnasitermes*. If the workman does not see any exterior galleries, but finds a few little pellets of wood, on the floor, he knows the *Calotermes* are in the wood. The remedy in each case must be different. These simple designations can be understood by those, who must deal with the subject practically.

Lantern-slide No. 4 shows the representation, nearly full size, of one of the largest nests of *Milesnasitermes* yet found upon the Isthmus. It was in a store-house, and was 10 ft. in height,—greatest width 2½ft., and greatest depth 1½ft., estimated weight 300 lbs. The wood of the building was badly injured, while galleries ran from this to other buildings. One gallery ran to a chapel, and the organ was destroyed.

Slide No. 5 shows a mud nest of *Termes columnar*, at Ceroyal Station of the Panama R.R., on the Pacific slope. It is over 5ft. in diameter on the base, and nearly 4ft. high. It is very strong and readily holds up a man. These mud nests have only been discovered on the Pacific slope. A species quite similar has been found on the Atlantic slope, having a nest in a rotten stump.

Slide No. 6 shows Mr. Beaumont's study at Colon. On the table is his microscope and several of the ash blocks containing Termites for examination. It probably can be noticed that the table legs are in jars of water, which is a common custom on the Isthmus, to keep the Termites and common ants from the table.

On the table are two of Mr. Beaumont's glass termitaria,

each with a colony from the same nest of *Termes columnar*. He had a bridge connecting them, and the inmates built a gallery on it, and passed to and fro. He then took away the bridge, and each colony raised up a vertical gallery, one $11\frac{1}{2}$ inches high, the other $7\frac{1}{2}$ inches. A portion of a large nest of *Termes columnar* is shown on the table, which is cylindrical.

Slide No. 7 shows nests, galleries, queen-cells and one specimen of wood-tunneling by the *Calotermes*. The object of chief interest is a bridge, on which are built two galleries by two different species, which he had in one jar. The nests were side by side, without communication, and when they wished to cross the bridge each built a covered gallery.

It is hardly necessary to state that the beautiful slides of sections of the queen Termites were prepared by Mr. Ludwig Riederer, to whom I am much indebted for his invaluable assistance in the study of the anatomy of the Termites.

SPIRAL, OR ELLIPTICALLY WOUND TRACHEIDS, IN THE AXILLA OF SMALL DECAYED BRANCHES IN TREES.

BY P. H. DUDLEY, C. E.

(*Read January 17th*, 1890.)

The spiral, or elliptically wound tracheids. in the pieces of Yellow Pine, *Pinus palustris*, Mill., and White Cedar, *Chamæcyparis Sphæroidea*, Spach, before you this evening, are evidences of some of the wonderful phenomena, which trees possess during growth, of preserving the integrity of their structures.

I called your attention to these features last year, having noticed them very frequently in the above woods.

Continued work upon the decay of woods the past season leads me to believe, that similarly wound tracheids or fibres will be found in most species of wood grown in dense forests, where, for want of light, the lower branches die, are attacked by fungi, break off, and the stub is overgrown, the entire process constituting a system of natural pruning and protection. The more we study this process the more instructive and marvellous it becomes. For the growing cells of the trunk promptly take

in the situation, and effectually, as a rule, do that which is necessary to protect those already formed from the attacks of the fungi, and build up and carry on the structure of the tree unimpaired.

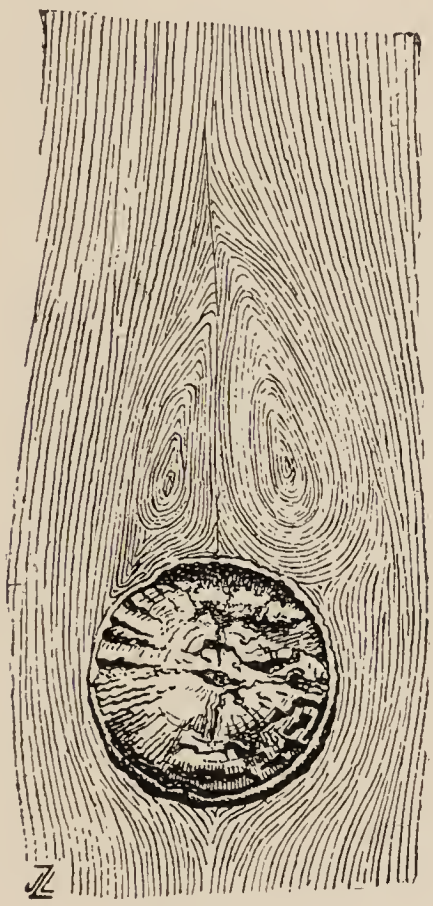

Fig. 1.

It is now well known that it is the function of many of the fungi by growth to undo the structure of the wood, cause it to decay, and reduce it to elements which again can be used by growing trees or plants.

For the growth of fungi, three conditions in combination are essential, viz.: 1st, *Moisture*; 2nd, *Heat*, ranging from 35° to 140° Fahr.: 3d, *Air*.

Eliminate any one of these conditions, and the growth of the fungi is checked, the wood not decaying.

To more readily trace the features of the natural system of pruning, and to see how the tree eliminates one of the conditions for the growth of the fungi, it will be well to recall to our minds a few facts regarding the growth of trees. They increase their height, year by year, by successive additions to the length of their leaders or leading branches.

When the lateral branches shoot off from the trunk, their height remains practically the same distance from the ground, as the tree grows. Whether all those branches will continue to develop, or the lower ones die, depends largely upon the amount of light the tree receives. Therefore, if the tree grows in an open field, it will be surrounded by light on all sides, which, acting on the chlorophyll in the leaves, will maintain the vigor and growth of all the branches. The trunk of the tree will be comparatively short, having many lateral branches. In this case, little if any natural pruning has taken place. On the other hand, when trees grow in the dense forests, only the uppermost branches receiving sufficient light for development, the lower ones being shaded, become dwarfed, die and are attacked by fungi. The

process of natural pruning takes place, and as a result those trees have tall branchless trunks, to the head of the tree.

From the above we can understand what is shown to have taken place in the specimens of wood before us.

Fig. 1 is a representative of the tangential section of Yellow Pine, enlarged to 1½ diameters, showing the elliptically wound

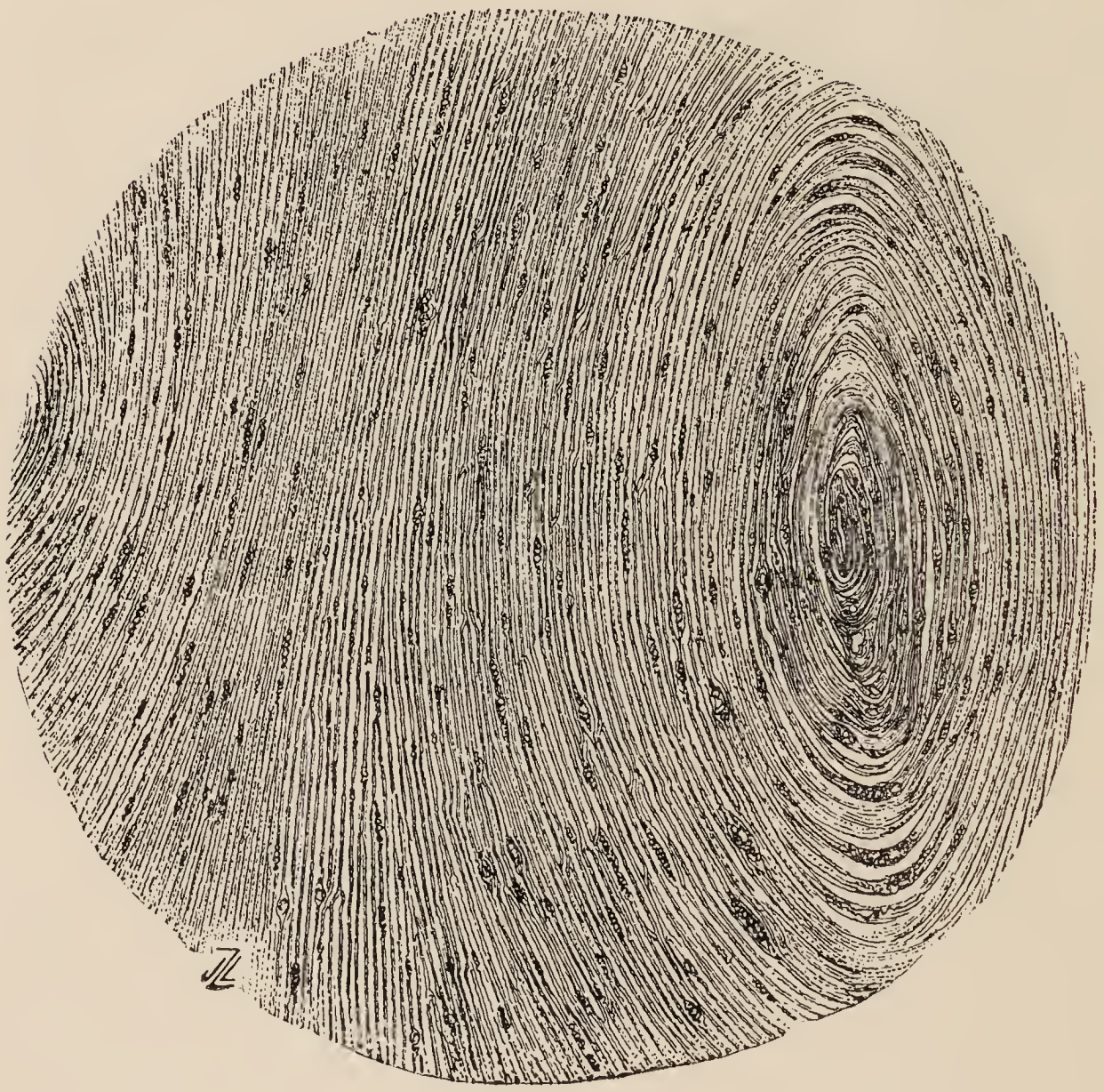

Fig. 2.

tracheids, which have formed in the axilla of the dead branch. Fig. 2 shows a portion of the same tracheids, enlarged to 15 diameters.

Figs. 3 and 4 show similarly wound tracheids from the White edar. Fig. 3 is enlarged to 1½ diameters and Fig. 4 to 15 diameters.

As soon as the lower branches die, the tree not only makes strenuous efforts to protect itself from the attacks of fungi

around and through the limb, but also to rid itself of the useless member. The cells of the cambium layer of the branch no longer being active those of the trunk are rolled out, pressing firmly against the lower, right and left sides of the branch, over the upper side, or the *axilla* of the branch, the expanding cambium layer would be separated for a short distance, leaving a triangular, or heart-shaped space. To close up this space is the function of the spiral, or elliptically wound tracheids. At first there is usually but one series ; but as the tree increases in diameter, and the branch is compressed in diameter, a second, and, sometimes, a third series form, as is the case of the White Cedar illustrated.

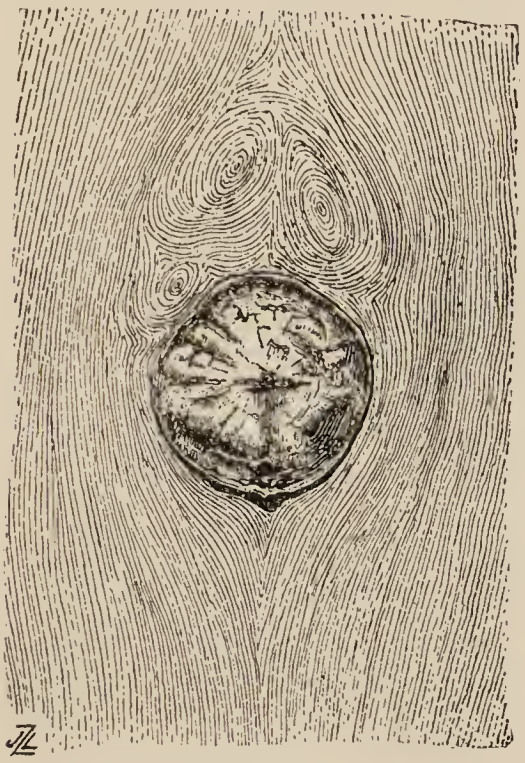

FIG. 3.

This tree growing in swampy ground, is a slow grower, and a durable wood. It decays slowly, even when attacked by its special fungus, *Agaricus campanella*, Batsch. It takes many years for the wood to grow over the stub of the decayed branch, and in many cases the fungus will work through the stub to the upright cells of the tree, and start a small zone of decay. The increasing spirally wound tracheids check the air supply, eventually cutting it off, eliminating one of the essential conditions in the combination for the growth of the mycelium of the fungus, and further decay of the living tree is arrested.

Timber cut from the White Cedar often shows many zones, where decay has started and has been subsequently arrested. In all cases these zones of decay have been started around the decayed branches, and arrested as described. The mycelium in these zones of decay will remain dormant for years, but will revive if the tree is cut into timber and used, when all of the conditions for the growth of fungi are in combination. Yellow Pine being a more rapid tree to grow than the White Cedar, the stubs of the decayed branches are more quickly overgrown, and we do not find the upright cells of the wood as frequently at-

tacked as in the White Cedar. The mycelium, however, of its special fungus, *Lentinus lepideus*, is frequently found in the overgrown stubs, and, when the wood is used for ties, it revives and fruits. It is very destructive to the wood, when the latter is used in contact with the soil; the resin in the wood furnishing little resistance to its ravages.

FIG. 4.

The growing trees of Yellow Pine protect the duramen of their trunks from its destruction, by closing up their wounds, shutting off the air supply and breaking the combination of conditions essential to its growth.

From these illustrations a very practical lesson is to be learned, and that is, in pruning trees, we ought to follow nature and protect the wounds, otherwise, if the tree cannot do it, the fungi will attack, and injure the tree.

PROCEEDINGS.

Meeting of April 18th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Thirty-eight persons present.

Mr. L. Riederer read by title a Paper, entitled "Notes on Staining Sections made by the Paraffin-Process enclosed in a film of Collodion." This Paper is published in the present volume of the Journal, p. 88.

The six low-power objectives, announced at the last meeting as purchased for the use of the Society, were placed in the care of the Curator, and the Committee on this matter was discharged.

Dr. Frank D. Skeel exhibited a one-inch objective of his own grinding and mounting, and explained some points of interest in the combination. It is a triplet, the central glass, crown, with a radius of .41 inch, and the two outer glasses, flint, with radii of .80 inch. The combination gives good working distance, plenty of light, and good definition, and would be very useful for dissecting purposes. The skill and success of Dr. Skeel shown in the manufacture of this objective were commended by Mr. William Wales.

The Paper announced on the programme for the evening, and entitled "The Long Island Oyster" was read by Dr. Bashford Dean. This Paper was illustrated by black-board drawings, and by a large collection of interesting specimens. A discussion followed, participated in by Messrs. F. W. Devoe and F. W. Leggett, and Dr. Paul Hoffman.

Meeting of May 2nd, 1890.

The President, Mr. P. H. Dudley, in the chair.

In the absence of the Secretary, Mr. George E. Ashby was elected Secretary *pro tem.*

OBJECTS EXHIBITED.

1. Microscope stand and objectives, used by the late Dr. J. W. Draper in taking photomicrographs, and also specimens of these photomicrographs on daguerreotype plates; loaned for the occasion by his son, Dr. Daniel Draper: by P. H. Dudley.

2. Spiracles of the larva of the Nut-weevil.
3. Spiracles of the Roach.
4. Spiracles of Dragon-fly.
5. Spiracles of the larva of the Hawk-moth.
6. Spiracles of Cicada.
7. Spiracles of Bishop's Mitre.

Nos. 2–7 by F. W. LEGGETT.

8. A Turn-table modified for cutting cells : by FRANK D. SKEEL.

9. Sections of petrified wood from Cairo, Egypt, collected by Dr. H. Carrington Bolton : by T. B. BRIGGS.

10. Section of red Syenite from the Obelisk in Central Park, New York : by T. B. BRIGGS.

11. Spicules and gemmules of Sponge from nest of Termites, prepared by Mr. J. Beaumont, Colon, S. A.: by P. H. DUDLEY.

12. Pond-life ; *Melicerta ringens*, *M. tubicularia*, *Actinosphærium Eichhornii*, *Paludicella Ehrenbergii* (one week old) : by STEPHEN HELM, of 417 Putnam Avenue, Brooklyn, N. Y.

Mr. Dudley explained his exhibit of the stand and objectives used by the late Dr. J. W. Draper, and read an account of the process employed, as described in Dr. Draper's "Scientific Memoirs."

Dr. E. G. Love questioned the claim for Dr. Draper, that he had taken the first photomicrographs, and pointed to the facts that Sir Humphry Davy and Wedgewood in 1802, succeeded in producing photomicrographs by the sun-microscope, which, however, were not permanent ; that Dr. Hodgson in 1840, using the gas-microscope and daguerreotype plates, produced photomicrographs ; and that in France, in 1844, there was published an atlas of photomicrographs ; while Dr. Draper's work was done between 1851 and 1856.

Mr. F. W. Leggett described at length and in an interesting manner his exhibit of spiracles from six orders of insects.

Dr. F. D. Skeel described his modification of the turn-table for cutting cells and accomplishing similar work.

Mr. C. F. Cox said that he naturally felt interested in any modification of this useful accessory to the microscope, but he wished to improve this opportunity to protest against the unnecessary complication and expense, which had been introduced into the self-centering turn-table by manufacturers, since

he first brought it forward in 1875. Nearly all present makers, he believed, employed a coiled spring to move the clutches, and this was either so stiff as to need care to prevent its chipping the slide, or else was not stiff enough to permit of the application of a cutting tool to the cell while upon the table, and most of the arrangements, which had come under his notice, required the use of both hands to place or to release the slide. He felt sure that the right and left screw was altogether the most convenient, effective and economical mechanism for controlling the clutches, and thought the manufacturers would confer a great benefit upon the preparers of specimens if they would return to that original and simple device.

Mr. Stephen Helm, in relation to his exhibit, stated that in England he had never seen a branched *Melicerta*, while here such a form is very common, and seems peculiar to America. He had lately found one specimen with thirty-six branches.

Mr. Dudley explained the sections of petrified wood from Cairo, Egypt, and also the spicules and gemmules of sponge from a Termite's nest from Colon, S. A.

The Secretary announced that the Department of Microscopy of the Brooklyn Institute would hold its Annual Reception on the evening of the 8th inst., and that he had received programmes and tickets of admission for the use of the Society.

On motion it was resolved that the thanks of the Society be hereby tendered the Department of Microscopy of the Brooklyn Institute.

Meeting of May 16th, 1890.

The President, Mr. P. H. Dudley, in the chair.

objects exhibited.

1. Sections of Chalcedony in agate: by T. B. Briggs.
2. Sections of a Meteorite, which fell May 2nd, 1890, in Iowa: by George F. Kunz.
3. Serial sections of the Brook Trout, two days from the egg: by L. Riederer.
4. *Termes flavipes*, soldier: by P. H. Dudley.
5. *Calotermes milesnasitermes*, soldier: by P. H. Dudley.
6. The same, young, with the beak just developing: by P H. Dudley.

7. *Termes flavipes*, Kollar, worker : by J. L. Zabriskie.

8. The same, soldier : by J. L. Zabriskie.

9. The same, female, winged and fully developed preparatory to swarming : by J. L. Zabriskie.

10. Large cells and tunnels in wood, made by these Termites : by J. L. Zabriskie.

Dr. Dean explained, with black-board drawings, the remarkable points of Mr. Riederer's serial sections of the Brook Trout.

Mr. Dudley explained, with black-board drawings, the method of growth and repair of the beaks and mandibles of *Calotermes milesnasitermes*, and also read a communication from Mr. J. Beaumont, of Colon, S. A., a Corresponding Member of the Society, on the swarming of the Termites of that locality.

Mr. Zabriskie said of his exhibit : These are specimens of our only native species of Termite, and they are all taken from one colony, found, on the 10th of the present month, in a piece of White Pine plank lying on the ground, at the Water Works, Flatbush, Long Island. The region is so frequented by entomologists that nearly every available piece of wood lying upon the ground is turned, about once in every twenty-four hours, in search of prey. But this piece of plank happened to be concealed in a clump of shrubbery, and had probably lain undisturbed for a long time. The colony was strong in numbers, and the tunnels and cells excavated in the wood were unusually large. One of the cells here exhibited measures ½ × 1 inch in diameter, and three inches in length.

Colonies are abundant in this locality in decaying stumps, pieces of board, or in any other wood lying for any considerable time upon the ground. During this present season the first observed males and females with wing-pads were found in a decaying stump on April 19th. On May 7th, in another stump were found males and females further advanced, some still with wing-pads, but others with thoracic and abdominal rings becoming darkened, and with full-sized wings, although the wings of all were still ivory white. It will be observed that the female here exhibited, taken on May 10th, has the color of full development—head and rings nearly black, and wings transparent with dark veins. After the early days of June no winged specimens were found.

The following donations to the Library were made by Mr.

William G. DeWitt : Hand-Book of Invertebrate Zoology, W. K. Brooks ; Guide to the Microscope in Botany, Behrens ; The Microscope, vols. vi-ix ; Journal of the Postal Microscopical Club, 1882-1889.

Meeting of June 6th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Fifteen persons present.

On motion the New York Mineralogical Club was invited to hold a joint meeting with this Society at the rooms of the latter on June 20th.

The Secretary read a Paper by Mr. George F. Kunz on the Meteorite recently fallen in Winnebago County, Iowa. Specimens of this were exhibited and commented on by Mr. T. B. Briggs.

The Secretary read a letter from Mr. J. Beaumont of Colon, S. A., upon the swarming of the White Ants, *Termes testaceus*.

Meeting of June 20th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Forty-four persons present.

In the absence of the Secretary, Mr. Anthony Woodard was elected Secretary *pro tem.*

Mr. Charles S. Shultz, of the Board of Managers, made a statement of the proposed change of the place of meeting, from the present rooms to the first floor of the same building.

The joint meeting of the New York Mineralogical Club and the Society was addressed by the Rev. G. G. Rakestraw, of Philadelphia, on "Microscopical methods in Mineralogy, with especial reference to the mounting of opaque objects."

The Address was illustrated by a large number of beautiful and valuable specimens, as announced below, from the collection of the speaker.

OBJECTS EXHIBITED.

From the collection of the Rev. G. G. Rakestraw.

Native copper, chrysocolla, cuprite, azurite, hydrocuprite, malachite, native copper and cuprite, aragonite and selenite, Cornwall, Penn.

Copper ores from Utah, Colorado and Arizona, consisting of brochantite, clinoclasite, tyrolite, olivenite, conichalcite, cuprite, azurite and malachite.

Descloizite and brown vanadinite from New Mexico.

Vanadinite in a variety of forms from Arizona. Vanadinite in calcite, Collateral mines, Arizona.

Pharmacosiderite, scorodite and jarosite from Utah.

Lettsomite from Arizona. Lanthanite from Saucon Valley, Pennsylvania.

FOREIGN MINERALS.

Green garnets, Orford, Quebec, Canada.

Aurichalcite, Atacamite and Proustite : Chili.

Celestite, Sicily. Hematite crystallized from England.

Hematite crystals with double terminated quartz crystals on the sharp ages of the hematite, England.

Percylite, South Africa. Herrengrundite from Herrengrund, Hungary.

Pucherite, Saxony. Eleonorite, Prussia. Liroconite and Torbernite from Cornwall, England. Gothite in quartz. Variety of Pyrrhosiderite, Prussia, etc.

Also a large series of fine mounted minerals loaned by Mr. George W. Fiske, of Philadelphia, Pa.

On motion the thanks of the joint meeting were tendered the Rev. G. G. Rakestraw for this Address and exhibition.

Vice-President Hyatt announced the next meeting of the American Society of Microscopists, to be held at Detroit, Michigan, on August 13th, 1890.

On motion the Society adjourned until the first Friday of October next.

PUBLICATIONS RECEIVED.

The Microscope : Vol. X., Nos. 6–8 (June–August, 1890).

The American Monthly Microscopical Journal : Vol. XI., Nos. 6–8 (June–August, 1890).

The San Francisco Microscopical Society : Proceedings (June 4–September 17, 1890).

The Botanical Gazette : Vol. XV., Nos. 6–9 (June–September, 1890).

Bulletin of the Torrey Botanical Club : Vol. XVII., Nos. 6–9 (June–September, 1890).

Insect Life : Vol. II., No. 11—Vol. III., No. 1 (May–August, 1890).

Psyche : Vol. V., Nos. 170, 171 (June, July, 1890).

Entomologica Americana : Vol. VI., Nos. 7–9 (July–September, 1890).

The School of Mines Quarterly : Vol. XI., No. 4 (July, 1890).

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The West American Scientist : Vol. VII., Nos. 50–52 (June–August, 1890).

Crystallogenesis : by Dr. H. Hensoldt (May, 1890).

United States Geological Survey : 8th Annual Report (1886, 1887).

The Brooklyn Medical Journal : Vol. IV., Nos. 7–9 (July–September, 1890).

Indiana Medical Journal : Vol. VIII., No. 12—Vol. IX., No. 3 (June–September, 1890).

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The Pacific Record of Medicine and Surgery : Vol. V., No. 1 (August, 1890).

The American Lancet : Vol. XIV., Nos. 6–9 (June–September, 1890).

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National Druggist: Vol. XVI., No. 12—Vol. XVII., No. 6 (June 15–September 15, 1890).

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Journal of the Royal Microscopical Society: Parts 3, 4 (June, August, 1890).

Journal of Microscopy and Natural Science: Vol. III., No. 3 (July, 1890).

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Nottingham Naturalist's Society: Transactions and Report (1889).

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The Ottawa Naturalist: Vol. IV., Nos. 4–6 (July–September, 1890).

Proceedings of the Canadian Institute: Vol. XXV., No. 153 (April, 1890).

The Canadian Record of Science: Vol. IV., No. 3 (July, 1890).

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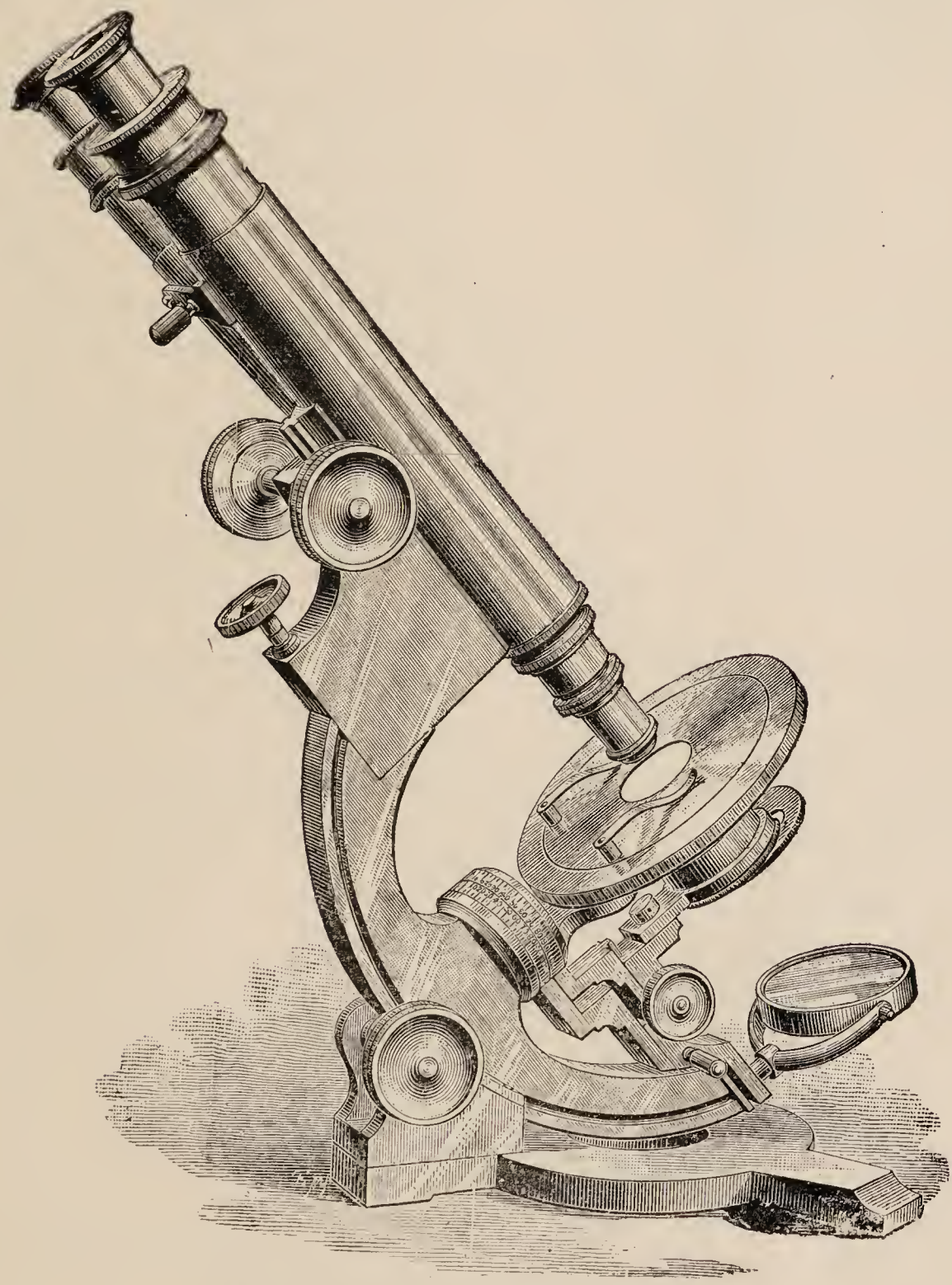

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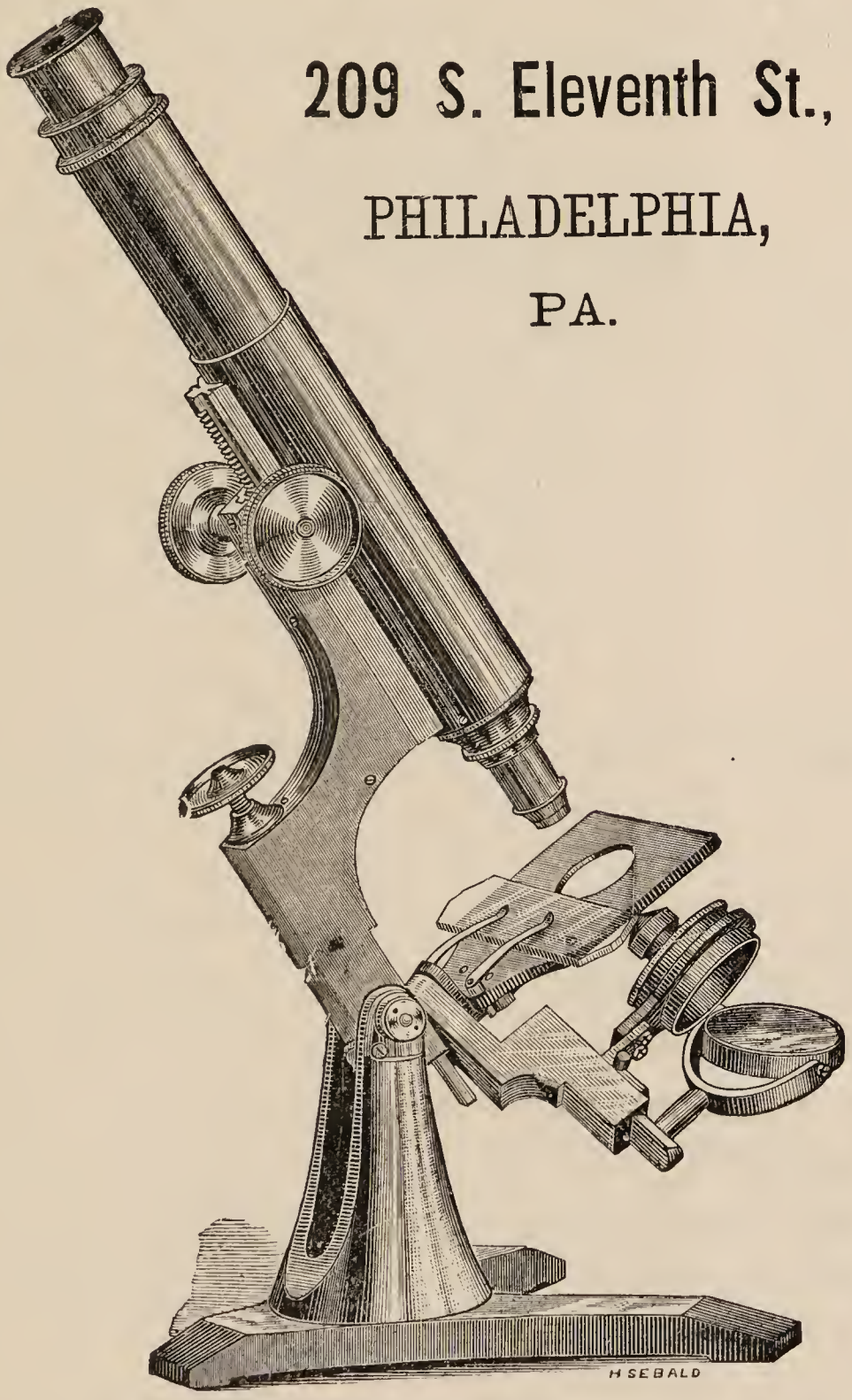

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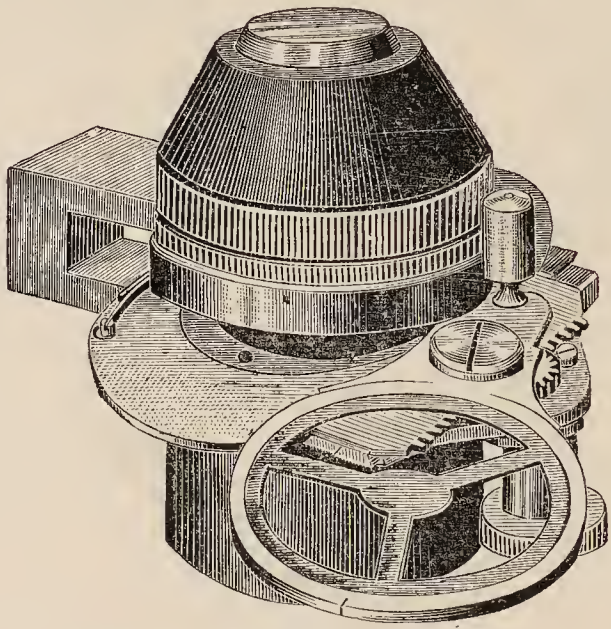

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I. Numerical Aperture Table.*

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a Microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media and in all cases by $n \sin u$, n being the refractive index of the medium and u the semi-angle of aperture. The value of $n \sin u$ for any particular case is the "*numerical aperture*" of the objective.

Numerical Aperture. ($n \sin u = a$.)	Angle of Aperture ($= 2u$.)			Illuminating Power. (a^2.)	Theoretical Resolving Power, in Lines to an Inch. ($\lambda = 0{\cdot}5269\ \mu$ = line E.)	Penetrating Power. $\left(\frac{1}{a}\right)$
	Dry Objectives. ($n = 1$)	*Water-Immersion* Objectives. ($n = 1{\cdot}33$.)	*Homogeneous-Immersion* Objectives. ($n = 1{\cdot}52$.)			
1·52	..	..	180° 0′	2·310	146,528	·658
1·50	..	..	161° 23′	2·250	144,600	·667
1·48	..	..	153° 39′	2·190	142,672	·676
1·46	..	..	147° 42′	2·132	140,744	·685
1·44	..	..	142° 40′	2·074	138,816	·694
1·42	..	..	138° 12′	2·016	136,888	·704
1·40	..	..	134° 10′	1·960	134,960	·714
1·38	..	..	130° 2′	1·904	133,032	·725
1·36	..	..	126° 57′	1·850	131,104	·735
1·34	..	..	123° 40′	1·796	129,176	·746
1·33	..	180° 0′	122° 6′	1·770	128,212	·752
1·32	..	165° 56′	120° 33′	1·742	127,248	·758
1·30	..	155° 38′	117° 34′	1·690	125,320	·769
1·28	..	148° 28′	114° 44′	1·638	123,392	·781
1·26	..	142° 39′	111° 59′	1·588	121,464	·794
1·24	..	137° 36′	109° 20′	1·538	119,536	·806
1·22	..	133° 4′	106° 45′	1·488	117,608	·820
1·20	..	128° 55′	104° 15′	1·440	115,680	·833
1·18	..	125° 3′	101° 50′	1·392	113,752	·847
1·16	..	121° 26′	99° 29′	1·346	111,824	·862
1·14	..	118° 0′	97° 11′	1·300	109,896	·877
1·12	..	114° 44′	94° 56′	1·254	107,968	·893
1·10	..	111° 36′	92° 43′	1·210	106,040	·909
1·08	..	108° 36′	90° 33′	1·166	104,112	·926
1·06	..	105° 42′	88° 26′	1·124	102,184	·943
1·04	..	102° 53′	86° 21′	1·082	100,256	·962
1·02	..	100° 10′	84° 18′	1·040	98,328	·980
1·00	180° 0′	97° 31′	82° 17′	1·000	96,400	1·000
0·98	157° 2′	94° 56′	80° 17′	·960	94,472	1·020
0·96	147° 29′	92° 24′	78° 20′	·922	92,544	1·042
0·94	140° 6′	89° 56′	76° 24′	·884	90,616	1·064
0·92	133° 51′	87° 32′	74° 30′	·846	88,688	1·087
0·90	128° 19′	85° 10′	72° 36′	·810	86,760	1·111
0·88	123° 17′	82° 51′	70° 44′	·774	84,832	1·136
0·86	118° 38′	80° 34′	68° 54′	·740	82,904	1·163
0·84	114° 17′	78° 20′	67° 6′	·706	80,976	1·190
0·82	110° 10′	76° 8′	65° 18′	·672	79,048	1·220
0·80	106° 16′	73° 58′	63° 31′	·640	77,120	1 250
0·78	102° 31′	71° 49′	61° 45′	·608	75,192	1·282
0·76	98° 56′	69° 42′	60° 0′	·578	73,264	1·316
0·74	95° 28′	67° 36′	58° 16′	·548	71,336	1·351
0·72	92° 6′	65° 32′	56° 32′	·518	69,408	1·389
0·70	88° 51′	63° 31′	54° 50′	·490	67,480	1·429
0·68	85° 41′	61° 30′	53° 9′	·462	65,552	1·471
0·66	82° 36′	59° 30′	51° 28′	·436	63,624	1·515
0·64	79° 35′	57° 31′	49° 48′	·410	61,696	1·562
0·62	76° 38′	55° 34′	48° 9′	·384	59,768	1·613
0·60	73° 44′	53° 38′	46° 30′	·360	57,840	1·667
0·58	70° 54′	51° 42′	44° 51′	·336	55,912	1·724
0·56	68° 6′	49° 48′	43° 14′	·314	53,984	1·786
0·54	65° 22′	47° 54′	41° 37′	·292	52,056	1·852
0·52	62° 40′	46° 2′	40° 0′	·270	50,128	1·923
0·50	60° 0′	44° 10′	38° 24′	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the *angular* aperture view as follows :—106° (air), 15[illegible] (air), 142° (water), 130° (oil).

Their actual apertures are, however, as ·80 (air), ·98 (air), 1·26 (water), 1·38 (oil), or their numerical apertures.

* From The Journal of the Royal Microscopical Society.

II. Conversion of British and Metric Measures.

(1.) Lineal.

Micromillimetres, &c., into Inches, &c.

μ	ins.
1	·000039
2	·000079
3	·000118
4	·000157
5	·000197
6	·000236
7	·000276
8	·000315
9	·000354
10	·000394
11	·000433
12	·000472
13	·000512
14	·000551
15	·000591
16	·000630
17	·000669
18	·000709
19	·000748
20	·000787
21	·000827
22	·000866
23	·000906
24	·000945
25	·000984
26	·001024
27	·001063
28	·001102
29	·001142
30	·001181
31	·001220
32	·001260
33	·001299
34	·001339
35	·001378
36	·001417
37	·001457
38	·001496
39	·001535
40	·001575
41	·001614
42	·001654
43	·001693
44	·001732
45	·001772
46	·001811
47	·001850
48	·001890
49	·001929
50	·001969
60	·002362
70	·002756
80	·003150
90	·003543
100	·003937
200	·007874
300	·011811
400	·015748
500	·019685
600	·023622
700	·027559
800	·031496
900	·035433
1000	(= 1 mm.)

mm.		ins.
1		·039370
2		·078741
3		·118111
4		·157482
5		·196852
6		·236223
7		·275593
8		·314963
9		·354334
10	(1 cm).	·393704
11		·433075
12		·472445
13		·511816
14		·551186
15		·590556
16		·629927
17		·669297
18		·708668
19		·748038
20	(2 cm.)	·787409
21		·826779
22		·866150
23		·905520
24		·944890
25		·984261
26		1·023631
27		1·063002
28		1·102372
29		1·141743
30	(3 cm.)	1·181113
31		1·220483
32		1·259854
33		1·299224
34		1·338595
35		1·377965
36		1·417336
37		1·456706
38		1·496076
39		1·535447
40	(4 cm.)	1·574817
41		1·614188
42		1·653558
43		1·692929
44		1·732299
45		1·771669
46		1·811040
47		1·850410
48		1·889781
49		1·929151
50	(5 cm.)	1·968522

mm.		ins.
51		2·007892
52		2·047262
53		2·086633
54		2·126003
55		2·165374
56		2·204744
57		2·244115
58		2·283485
59		2·322855
60	(6 cm.	2·362226
61		2·401596
62		2·440967
63		2·480337
64		2·519708
65		2·559078
66		2·598449
67		2·637819
68		2·677189
69		2·716560
70	(7 cm.)	2 755930
71		2.795301
72		2·834671
73		2·874042
74		2·913412
75		2·952782
76		2.992153
77		3 031523
78		3·070894
79		3·110264
80	(8 cm.)	3·149635
81		3·189005
82		3·228375
83		3·267746
84		3·307116
85		3·346487
86		3·385857
87		3·425228
88		3·464598
89		3 503968
90	(9 cm.)	3·543339
91		3·582709
92		3·622080
93		3·661450
94		3·700820
95		3·740191
96		3·779561
97		3·818932
98		3·858302
99		3·897673
100	(10 cm. = 1 decim.)	

decim.	ins.
1	3·937043
2	7·874086
3	11·811130
4	15·748173
5	19·685216
6	23·622259
7	27·559302
8	31·496346
9	35·433389
10 (1 metre)	39·370432

= 3·280869 ft.
= 1·093623 yds.

Inches, &c., into Micromillimetres, &c.

ins.	μ
$\frac{1}{25000}$	1·015991
$\frac{1}{20000}$	1·269989
$\frac{1}{15000}$	1·693318
$\frac{1}{10000}$	2·539977
$\frac{1}{9000}$	2·822197
$\frac{1}{8000}$	3·174972
$\frac{1}{7000}$	3·628539
$\frac{1}{6000}$	4·233295
$\frac{1}{5000}$	5·079954
$\frac{1}{4000}$	6·349943
$\frac{1}{3000}$	8·466591
$\frac{1}{2000}$	12·699886
$\frac{1}{1000}$	25·399772

	mm.
$\frac{1}{900}$	·028222
$\frac{1}{800}$	·031750
$\frac{1}{700}$	·036285
$\frac{1}{600}$	·042333
$\frac{1}{500}$	·050800
$\frac{1}{450}$	·056444
$\frac{1}{400}$	·063499
$\frac{1}{350}$	·072571
$\frac{1}{300}$	·084666
$\frac{1}{250}$	·101599
$\frac{1}{200}$	·126909
$\frac{1}{150}$	·169332
$\frac{1}{100}$	·253998
$\frac{1}{50}$	·507995
$\frac{1}{25}$	1·015991
$\frac{1}{20}$	1·269989
$\frac{1}{16}$	1·587486
$\frac{1}{15}$	1·693318
$\frac{1}{12}$	2·116648
$\frac{1}{10}$	2·539977
$\frac{1}{8}$	3·174972
$\frac{1}{6}$	4·233295
$\frac{3}{16}$	4·762457
$\frac{1}{5}$	5·079954
$\frac{1}{4}$	6·349943
$\frac{5}{16}$	7·937429
$\frac{3}{8}$	9·524915

	cm.
$\frac{7}{16}$	1·111240
$\frac{1}{2}$	1·269989
$\frac{9}{16}$	1·428737
$\frac{5}{8}$	2·587486
$\frac{11}{16}$	1·746234
$\frac{3}{4}$	1·904983
$\frac{13}{16}$	2·063732
$\frac{7}{8}$	2·222480
$\frac{15}{16}$	2·381229
1	2·539977
2	5·079954
3	7·619932

	decim.
4	1·015991
5	1·269989
6	1·523986
7	1·777984
8	2·031982
9	2·285979
10	2·539977
11	2·793975
1 ft.	3·047973

	metres.
1 yd. =	·914392

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